THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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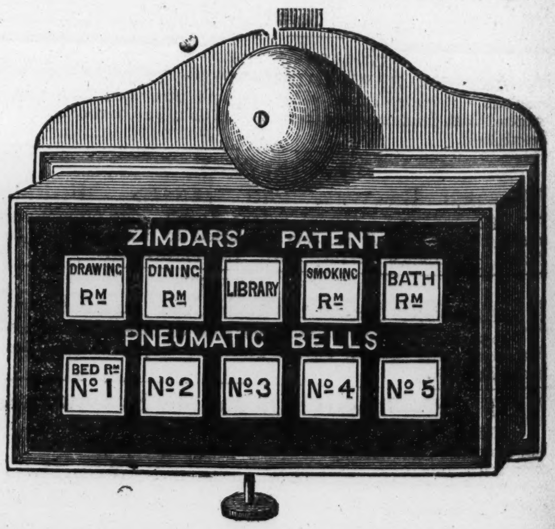

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THE TELEGRAPHIC JOURNAL.

Vol. III.—No. 62.

ON A SYSTEM OF TELEGRAPHY.

A Course of Lectures, delivered at the School of Military Engineering, Chatham,

By W. H. PREECE, Member Inst. C.E., &c.

Lecture I.—A System of Telegraphy as applied to Railway Purposes.

The subject of Telegraphy—upon which I have been invited to lecture to you—has been well nigh exhausted by the eminent lecturers who have preceded me. Professor Fleeming Jenkin detailed to you, with that clearness for which he is so celebrated, all that was then known—and little has since been added—of the theoretical branch of the subject; Mr. Culley developed before you all that was then known, to which little or nothing has since been added of the practical bearing of this subject; and Mr. Sabine indoctrinated you into the mysteries and intricacies of Submarine Telegraphy. Your own *Professional Papers* contain a vast store of valuable information on both the theory and practice of Telegraphy, so that apparently there is little left for the lecturer to submit to you upon this subject without retracing ground that has already been crossed.

The Art of War, however, has been well nigh revolutionized during the last few years, and no fact has been brought out with greater force than that in all future wars the railway and the telegraph, jointly and separately, must play a fundamental part.

In America, manœuvres on a grand scale were undertaken to destroy the enemy's railways and telegraphs, and in the great seven weeks' war between Prussia and Austria the value to the enemy of the creation of obstructions to these communications, and to the invaders of their rapid removal, was one of the chief lessons learnt. Even in our little war in Ashantee the complete equipment of a section of a railway has been sent out, though—apparently, and unfortunately—its adoption has been found impracticable, and at the last moment a fully equipped telegraph has followed. In Abyssinia the telegraph, as well as the little railway of 12 miles long, played a most important part; and though it would be too much to say that without them the result would not have been so successful, there is no doubt that with them the advance was expedited and the return hastened. Indeed the experience gained in Abyssinia has probably led to the spirited action of the War Office in the Gold Coast Railway.

The rapidity and completeness of the successes of the Germans in the late—as well as in the seven weeks' war—were unquestionably due to the facilities offered conjointly by the railways and the telegraphs, and the skill and forethought with which they were utilized. In fact it is said that, with the wires in his tent, Count Moltke was able to manœuvre his forces as the chess-player would make his moves upon the table before him. On the other hand for two days during a very critical period the French Emperor was left without news of any kind of MacMahon and De Failly, and the great trial which is now progressing at Versailles gives plenty of evidence of the fact that although the telegraph was much used by the French, their generals were manœuvreing in the dark from the absence of that light which was supplied to the Germans by their efficiently organized telegraph. The character of the French renders them eminently theoretical in their ideas. Their plans and systems partake much of this nature. Before the war their railway and telegraph arrangements were theoretically all that could be desired, but tested by the severe ordeal of real practice they collapsed. The German plan, on the contrary, conceived by the severe logical method of that nation, experienced the pruning of practice in the seven weeks' war, and their system consequently proved a wonderful success.

I read in the *Pall Mall Gazette* for January 18th, 1873. "The importance of railway corps in time of war is constantly enforced upon us by the steps taken by Continental nations in this direction. It would seem that the necessity for such a trained service is held abroad to be one of the most obvious lessons of the late war. The military provisions of the abortive, or at least suspended, Swiss Constitution were intended to pave the way among other improvements to the promotion of a complete railway staff suitable for the exigencies of war, though maintained according to the ordinary Swiss principle, in a normal state of non-activity in time of peace, being, in fact, exercised only occasionally at convenient times. In Prussia we have just seen the Railway Abtheilung of 1870 enlarged into a complete engineer railway battalion. This is being initiated in France; and now Bavaria has created her own organization for the same purpose, modelled also on that of Prussia, but of more modest dimensions, being but one-fourth the strength of that maintained at Berlin. This new formation is a railway company with a peace establishment of six officers, twenty non-commissioned officers, and 104 rank and file, the last to be doubled from the reserve when the company takes its war footing. The corps is clothed as the engineers, but with a small distinctive mark, and in peace is to be subject to the same training and inspection. In war it is to be invariably attached to the headquarters of the First Corps. Its station for the present is at the fortress of Ingoldstadt, the chief strong place now exclusively in Bavarian hands."

In Austria there is a semi-civil organization which is intended on service to be placed under a civil chief. In Russia officers and men are distributed among the Railway Companies to learn railway duties. The Italians have increased each battalion of engineers by one railway company, and have established a very efficient system. France, with marvellous energy, has acted upon the lessons taught her by the collapse of her system and the success of that of the Germans. They have established a recognized military railway department, so as to secure unity of command, centralization of power, and a proper association in time of war of the military and civil elements. They are associating the technical railway staff with the military element by distributing soldiers among the principal railways and recruiting the ranks from the railway services.

I fear none of us individually take advantage of the experience of others. We simply regard the lessons we learn ourselves. It is so with nations. We see around us the grand military nations of Europe availing themselves actively of the experiences of the past, while we remain comparatively passive, or else make feeble copies of what others do.

Captain Tyler, R.E., no mean authority on railway matters, said before you in this room, "one single line of railway, properly laid, maintained, worked and guarded, is sufficient to keep up the necessary supplies of an army of almost any size." You have had personal experience of their efficiency in the Crimea, Abyssinia, and India, and we know the important part they played in the great civil war in America. They were used in the concentration of the French in Piedmont in 1859, and the Austrians brought up reinforcements by their aid during the battle of Magenta.

Since, therefore, we may conclude that railways and telegraphs will form a fundamental feature in all future wars, it is evident that the relations which they bear to each other, and the organization under which each must be administered separately and conjointly will form an essential feature in the education of our future Royal Engineers. In fact, the time must come when you will have Railway Companies as you now have Telegraph Companies, trained under a well organized system, and maintained in the healthy discipline of the constant and daily routine of practical duties. I have therefore determined to discuss before you the application of a system of telegraphy, 1st, to *Railway Working*, to show how the marshalling and movement of trains, their safety, regularity, and dispatch, depend essentially upon the use of the telegraph. 2ndly, to *Commercial Purposes*, to show how the support and control—if by control is meant the commisariat—of armies is dependent on the continuance of the commercial system in an invaded country. 3rdly, to *National and Imperial Purposes* in time of peace as well as of war; and lastly, to *Military Purposes* pure and simple.

I shall have to deal with these subjects in the short time allowed me more in a general than a particular sense, and to point out to you more their organization than their details. Indeed I conceive organization to be the point upon which information is chiefly needed, for details often shape themselves. Still there is an imperative necessity for him who is at the head of any branch of any profession to be complete master of all the details of his branch. "For want of a nail the shoe was lost." For want of knowledge of details armies have been lost. It is the marvellous knowledge of details which Mr. Scudamore possesses which has enabled him to administer the telegraph department of this country with such success; and the best administrators of our railway system are those who are cognizant of the minutest details of every branch of the service regulated by them.

I would strongly counsel all those who are placed in command of any telegraph work not to content themselves with the mere knowledge of the mode of operating an instrument or transmitting a message, but to master the scientific details and construction of the "wonder-working wire." Smiles says of the Duke of Wellington that "he habitually attended to the minutest details of all matters entrusted to him, whether civil or military. His business faculty was his genius, the genius of common sense, and it is not perhaps saying too much to aver that it was because he was a first-rate man of business that he never lost a battle." The Duke, had he lived in the present day, would have made himself something of a electrician as well as a railway manager; and those who aspire to be leaders must apply themselves to those simple, beautiful, and marvellous scientific principles upon which telegraphy is chiefly based.

But we have to-day to deal with—

RAILWAYS.

The rapid manner in which the Germans concentrated their armies for the defence of the Rhine, the skill with which they repaired and employed the French lines for their advance, for their supplies, for the return of the sick and wounded, and for the removal of the multitude of prisoners secured by their successes, show the value of a well organized system of managing railways; but there were not wanting *contretemps* to show the need of improvement in organization and the necessity of a thorough knowledge of railway working.

About the middle of December, General Faidherbe, taking the initiative, advanced on Amiens to meet General Manteuffel, and the result was the battle of the Halluc. It was highly important to the Germans that reinforcements should be rapidly brought up from Rouen. Six battalions were placed at the disposal of Manteuffel, but only two battalions arrived before the battle, two whilst it was being fought, and the remaining two the day after. The French having retreated, Manteuffel was able to comply with the urgent request of the General Commanding at Rouen, and to send back at once four out of the six battalions which had been borrowed. The return journey commenced on the 26th—only one battalion reached Rouen on that day, the three others not before the 28th and 29th.

In this particular instance the chief cause of delay was the want of rolling stock and engine drivers, but considering the distances concerned, it is evident that there were other causes which interfered with that prompt transport which sound organization secures. It forcibly shows the necessity of a knowledge of railways and railway working, and the attachment of a complete railway organization to the head quarters of an invading army.

Bourbaki's ill-success in the East was due to the collapse of the French system, and even with the Germans, French prisoners were kept three days in open wagons in intensely cold weather, whereby some of them were frozen to death.

The railway system of this country is a pure example of the principle of natural selection and of the survival of the fittest. Each railway company has passed through a similar course of creation and education. The teachings of experience are better than tall talk, and therefore in pointing out to you the gradual formation of a railway system in England, and of the united influence of evolution and experience, I think I shall best fulfil my duty as your mentor. I select that portion of the country with which I am most familiar, viz., the south-west, and in which I have not been an idler nor without having assisted somewhat in the process of organization. The success of the Manchester and Liverpool Railway led to many schemes. Stephenson and Locke who were there associated, separated, and the latter projected the London and South Western Line. The first through portion of this line opened was that between London and Southampton, in 1840. It was a double narrow gauge line. Only four trains were run each way each day. There was no telegraph. The trains were so few, they were separated by such a wide interval of time, that little or no danger existed. A high signal post, of a half moon pattern, was fixed at each station to warn an approaching engine-driver of obstruction when shunting and other operations were going on. The half moon seen wholly or partially on the left hand side was "obstruction" or "danger," and an intimation to the driver to stop at once; seen edge-wise or entirely on the right hand side it was "line clear," "go ahead." On the earlier lines the signals were entirely given by men with flags of different colours by day, and with burning tarred ropes by night.

The double railway was subsequently extended to Gosport in 1842, and to Portsmouth in 1848. It was then found at a busy junction, as Bishopstoke became, that a mere home signal was not sufficient to stop the driver, hence an auxiliary or distant signal was fixed 600 or 700 yards away from the station, which gave him the earliest instruction of the condition of the home signal. At night lamps were used, and their signification is given by the couplet:—

White means *right*, *red* means *wrong*,
Green means *slowly go along*.

And this system which I have described is that, in point of fact, which is in universal use throughout the railway world. Whenever or wherever danger exists from a stopping train, or from a train fouling a line at a junction or siding, a signal is erected, intimating to the driver of an approaching train, "danger" or "all right." A third signal,—the *caution* signal—is sometimes used, but its use is fast disappearing. To give the earliest intimation of this signal, distant signals are fixed as far off as possible, repeating the home signals. Sometimes they are worked together, sometimes they are worked independently of each other, but the principle remains the same. Innumerable forms of signal have been employed, but the semaphore is the favourite, and upon the principle of the survival of the fittest, there is no doubt that it will ultimately supplant every other form of signal. Its great advantage is, that seen from every point of view, its indications mean the same thing. This is not so with discs; seen at different angles they have different meanings.

(To be Continued.)

ON TELEGRAPH CONSTRUCTION.

By JOHN GAVEY, Assoc. Soc. T. E.

(Continued from page 178.)

THE following table, extracted from "Anderson's Strength of Materials," gives the force in lbs. per square inch necessary to cause rupture, both by a tensile strain, and by a crushing force; in the latter case only short pillars are referred to:—

Strength of timber to resist tensile and crushing forces.

Description of timber.	Tenacity in the per square inch of section.	Resistance to crushing per square inch of such.
Ash	15,784 to 19,600	8,683 to 9,363
Beech	11,500 „ 22.200	9,363 „ 7,733
Elm	13,489 „ 14.400	10,331
American Pine	12,000	5,375 to 6,819
Memel Pine	11,000	
Riga Pine	12,600	
Larch Fir	10,200	
Oak, English	15,000	6,484 to 10,058
„ African	14,400	
Canadian	12,000	7,731
Dantzic	14,500	12,101
Teak	8,200 to 15,000	

The resistance to a shearing force is about equal to the tensile strength of the timber across the fibres, when the force is transverse to them; and with the fibres, when it tends to rend them longitudinally. The transverse strength is that most called into requisition in telegraph construction, and the following table, the particulars of which have likewise been obtained from Anderson's work, gives the force necessary to fracture beams supported at both ends, one foot long and one inch square when loaded at the centre. The method of calculating from such a table the strength of any beam, when exposed to strain, will be dealt with, when we consider the actual erection of a line of telegraph. The results are those obtained by various experimenters, but the mean maximum and minimum only are quoted here. It may be assumed that, in obtaining these results, heart timber alone would be used, and that beams, containing any considerable proportion of sap wood, would be far inferior in strength, as compared with these figures.

Table of Transverse strengths of beams of timber, one foot long and one inch square when loaded at the centre.

Description of timber.	Force in lbs. to cause fracture.			No. of results.	No. of experimenters.
	Mean.	Maximum.	Minimum.		
Ash	690	810	595	7	5
Beech	623	704	518	4	3
Elm	405	540	343	4	3
American Pine	523	483	570	3	2
Memel „	561	577	545	2	1
Riga Fir	457	584	369	5	5
Larch Fir	440	632	284	5	3
English Oak	591	964	420	7	5
African Oak	855	855	855	1	1
Canadian	580	589	572	2	2
Dantzic	514	659	392	3	3
Teak	814	1,075	642	4	4

It will be obvious, both from an examination of the last table, and from the most cursory consideration of the subject, that the strength of any given class of timber will depend on so many different circumstances, such as rapidity of growth, soil, climate, state of seasoning, &c., that no hard and fast rule can be laid down for ascertaining the strength of any given consignment, and that actual experiments on a greater or lesser scale become necessary if accurate results are desired. Such accuracy, however, although needed in calculations for extensive engineering and architectural works, are not generally necessary in telegraph construction. Further, it appears to be a generally accepted opinon, that creosoting, boucherising, and other like preservative processes, perceptibly weaken the timber which undergoes them, rendering it "short," or in other words, liable to fracture under sudden or prolonged strains, more readily than ordinary seasoned timber. Definite experiments in this direction are wanting, and such would be of a highly interesting nature, if carefully carried out. It is, however, an undoubted fact that many railway companies have abandoned creosote for sleepers exposed to a heavy traffic, as the chairs cut their way more readily into the wood under the constant impact of passing trains than when it is merely seasoned in the usual manner; the timber being thereby more rapidly destroyed mechanically than ordinary timber would be by rot.

In selecting or purchasing timber, the following points should meet with particular attention. All poles should be sound, hard grown, straight, and free from large or dead knots and other defects. These should contain the natural butt of the tree, and be free from evidences of decay at the core when felled. They should be of slow growth, as in such a case there will be a lesser proportion of sap wood, and consequently they will possess greater strength and a less liability to decay. The rapidity or otherwise of the growth is seen by the dimensions of the "annual rings," and the proportion of sap and heart wood respectively is easily distinguished in a felled tree by the difference in colour and solidity. If timber is to undergo a preservative process, the amount of sap wood is not so material, as it will then affect the strength of the timber only, and not its durability. The diminished strength can be allowed for by increasing the dimensions.

The timber should be felled in winter say between the 1st day of November and the 28th February.

If poles have to be treated with preservative compounds, they should not be floated to the works, or exposed to the liability of becoming saturated with water in transit, for this vitiates the success of the subsequent operations, unless much loss of time is incurred in thoroughly drying out the absorbed moisture. They should, on delivery, be cross-stacked, so as to admit of a free circulation of air around and through them, for at least three months before they are immersed in the tanks; and they should be thoroughly dry when this is done. Poles in depot should, whenever possible, always be stacked at such a height from the ground as to be beyond the reach of vegetation. Further, each tier should be separated from the next ones by layers of dry sound timber, techinially termed *dunnage*. This allows a free circulation of air, and prevents the accumulation of damp, the formation of fungus, and the setting in of circumstances favourable to decay. This point is not material with creosoted timber.

The dimensions of telegraph poles of course vary with the class of line to be erected. The average lengths to be used have been referred to already. The diameters depend entirely on the number of wires to be carried. For one or two wires, poles 4 inches in diameter at the top will serve for three or four wires not less than five inches, and above that number six inches should be the minimum, a few poles of larger dimensions than the minimum, in every class of work, should always be provided for use in special cases. The theoretical law for obtaining the maximum strength, from a given quantity of timber, will be dealt with later, but in the meantime the following dimensions may be quoted as those frequently used. The poles are roughly divided into two classes, light and heavy, the former serving say for lines up to four wires, the latter for main lines :—

Length.	Light Poles.		Heavy Poles.	
	Diameter at top.	Diameter 5 ft. from butt.	Diameter at top.	Diameter 5 ft. from butt.
20 feet	4½	6½	..	..
26 "	5	7½	5¾	8½
30 "	5	8	6	9½
36 "	5½	9½	6½	10
40 "	5½	10	6½	11

(To be continued.)

GRAMME'S MAGNETO-ELECTRIC MACHINES.

By ALFRED NIAUDET-BREQUET.

(Continued from page 186.)

PECULIARITIES OF THE MACHINE.

FROM what has been said regarding its principle, it may be easily understood how continuous currents are supplied, and how their direction will change with the direction of rotation.

The continuity of the current is manifestly owing to the circumstance that the movement of the machine is continuous; that the circuit is never broken, since the rubbers or brushes begin to touch one of the pieces R before abandoning the preceding one, and because the flexible and multiple nature of these brushes guarantees that they always touch a "piece" by some one of its parts.

The strength of the current increases with the speed of rotation; experiments have proved that the electro-motive force is proportional to the speed. This has been several times completely verified in England and France—notably by the inventor himself by means of a small steam-motor of extremely regular movement.

At first sight it would seem that the resistance should remain constant; but it was soon noticed that the strength is not proportional to the speed of an invariable circuit, whence one is led to conclude that the resistance of the machine to the passage of the current is not constant. This important fact was pointed out for the first time by Mr. Robert Sabine. The increment of resistance is, however, small; so small that it may be safely admitted that a machine which gives, with a speed of 100 turns in a minute, a current equal to 1 Bunsen's element of small size, gives a current equal to 2 Bunsen's elements (of rather larger size) with 200 turns per minute; it will also give a current of 4 Bunsen's elements (rather larger still) with a speed of 400 turns a minute, and so on. This augmentation of the electro-motive force cannot be indefinite: it tends to a limit. But, as with speeds of 3,000 turns a minute the before mentioned proportionality still subsists, it may be granted that the limit is far from being attained, and answers to a speed almost impossible to realise in practice.

Upon the whole, M. Gramme's machine gives continuous currents similar to a battery; currents constant, if the movement be uniform; currents variable at will between very extended limits according to the speed of the rotatory movement.

To suit the purposes for which his machines are required, the inventor modifies them by winding upon the ring thin or thick wire, so as to produce either "intensity" or "quantity" effects. It appears indubitable that according to the speed of the ring the electro-motive force will be proportional to the number of helices, or coils of wire; but interior resistance increases in the same proportion, and in most cases best results are obtained by using thick wires. However, where the exterior circuit is of great resistance, as in telegraphy, it is better to use machines having thin wire.

Gramme Machines, without Permanent Magnets.

Those who have followed the progress of electro-magnetic motors for some fifteen years will remark that one of the chief improvements in the English machines consists in replacing the existing magnets of Pixii's, Saxton's, and Clarke's machines, with much more powerful *electro-magnets*, themselves excited by the action of the machine.

For small apparatus, M. Jamin's recent discovery of the means of procuring magnets of an extraordinary power at a relatively low cost, considerably lessens the importance of the preceding combination. But for industrial engines the use of electro instead of permanent magnets is rendered almost absolutely necessary.

It might be supposed that the magnetism induced in the electro-magnets would entail a considerable waste of electricity and force. M. Gramme shows, however, that this difficulty may be turned to account. If an electro-magnet is placed in the circuit of a Gramme machine, the current given out in the first instance magnetises it, and afterwards maintains its magnetism. It cannot be doubted that the production of this magnetism in the first almost instantaneous period does respond to a certain waste of electricity and force; but in the second period, what takes place? Reflection and experiment demonstrate that there is still a waste of electricity, and therefore of mechanical power. But M. Gramme has thought, not without reason, that the magnetic equilibrium once obtained, its maintenance would not require an expenditure of work any more than work would be required to maintain the support of a weight at a level to which it had been raised. He concluded that almost all the waste took place simply in the current's passage in the wire, and that it would be almost the same if the wire, instead of being wound in coils upon iron cores, was merely extended in a straight line.

He was thus induced to place the moveable ring, the exciting electro-magnet, and the electrical receiving apparatus (whether electroplating bath, or electric lamp) in one circuit. Under these circumstances it was useless to have two distinct rings—the one to excite the electro-magnets, the other to generate electricity for use: one ring only sufficed.

The wire wound round the electro-magnets adds a resistance to the circuit, and thus diminishes, in an inevitable manner, the strength of the current; but the shorter and thicker the wire the less is the strength of the current reduced: hence thick and short wire is used in all cases where practicable. For this reason he uses in some instances not wires but sheets of red copper as wide as the electro-magnet is long, and which are wound round upon themselves four or five times in spirals. We may therefore say that the force necessary to magnetise the exciting electro-magnets of these machines is almost nothing.

In order to obtain a high potential, a slight alteration has been made in the ring or "annular helix." It has already been described as consisting of 60 coils or elements in electrical communication with radiating pieces from which the current is collected by rubbers. M. Gramme has adopted the plan of putting on the right hand side of the ring all the *ingress* ends of 30 alternate coils, and on the left hand side all the *ingress* ends of the remaining 30 coils, as may be seen from Figure 8. The total sum of the force produced is thus divided into two parts collected by separate brushes—one on either side.

The advantages resulting from this arrangement are very great. It permits the battery to be joined up for either "intensity" or "quantity" purposes, so as to obtain very varied effects from the same machine, and to accomplish this by means of a simple commutator action. There are reasons for believing that a ring and its collecting-rubbers behave better when the machine is thus divided, and that each of the two portions of the divided ring is in a better condition for work than is an ordinary single ring. The last word, as regards this question, has not however yet been given.

Inverse Work.

Like all other magneto-electric machines, Gramme's has for its chief function the conversion of mechanical force into electricity; by the reconversion of electricity into a motive force it becomes an electro-magnetic machine. It has been found that by merely applying an electric source to the metallic brushes, the central ring immediately moves.

Having neither connection rod nor crank, &c., this instrument is eminently successful in producing work out of an electric curreut, as shown by the following results obtained out of a current from 2 to 10 Bunsen's elements of 20 centimetres each, and one of Jamin's magnets:—

Number of Elements.	Number of turns of the Ring.	Force in Kilogrammes.	REMAKKS.
2	760	0·320	Action irregular.
3	810	1·020	„ good.
4	1,000	1·600	—
4	900	1·800	—
5	1,100	2·500	—
6	1,000	3·360	„ irregular.
7	1,100	3·140	„ good.
8	1,100	5·000	—
8	900	4·807	—
9	1,500	5·115	The check balanced with great difficulty.
10	1,700	5·520	Action good.
10	1,300	6·165	„ irregular.

A striking experiment consists in placing two small Gramme's machines in the same circuit. If one is set in motion it furnishes a current which which passes into the second, and sets it likewise in motion. If the first is stopped, and the movement instantly continued in the contrary direction, the second also suddenly stops and resumes an inverse movement.

The following experiment is also not without interest. If the machine is turned and its current passed into a Planté's secondary battery, the battery becomes charged. On ceasing to turn and keeping the circuit entire, it will be found that the secondary current returns to the machine and causes the ring to turn in the same direction and for a similar period as before.

TRANSFORMATION OF "QUANTITY" INTO "INTENSITY" ELECTRICITY.

Just as Ruhmkorff's coils transform quantity electricity in the primary wire into intensity electricity induced in the secondary wires, so Monsr. Gramme has recently shown* that his machine will act in the same way. For this purpose he makes use of a "double ring," whose even coils are made of fine wire, and whose uneven coils are of coarse wire. This ring is placed between the poles of a magnet as in Fig. 4.

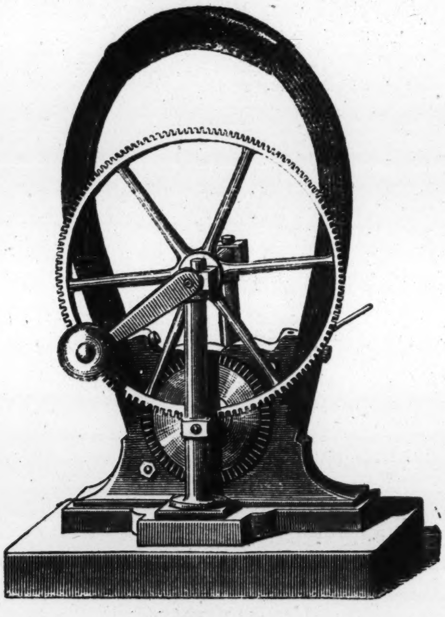

FIG. 4.

Let a battery current from two Bunsen's elements, be passed into the coarse wire, the ring begins to turn as already explained. Under this rotary influence, it will induce in the fine wire coils an ordinary "Gramme machine current;" but this induced current will be of much greater "intensity" than the Bunsen current. The ratio between the two currents is found as 1 to 8; for the current from 2 of Bunsen's elements induced another equal to 16 Bunsen's elements, equivalent to about 30 of Daniell's elements. Inversely we may obtain from a high intensity current one of quantity.

In these transformations there are losses more or less great, which may lead us to paraphrase a mechanical axiom—"*What is gained in "intensity" is lost in quantity, and inversely.*"

USE FOR SCIENTIFIC PURPOSES.

Monsr. Mascart was the first to point out the possibility of using this machine as a measure of electro-motive forces. The proportionality of potential to the speed of rotation having been verified between sufficiently extended limits (from 1 to 10 Bunsen), we are able by the method of opposition to measure any electro-motive force whatever by the rotatory speed of the ring during moment of equilibrium.

The speed may be reckoned by two methods—either by means of Deschien's velocimeter, or by a chromoscopic diapason. The velocimeter is an extremely convenient implement; it is simply necessary to affix it for ten or twelve seconds to the extremity of the axis to learn the number of revolutions made during that time.

But it frequently happens that we are not able to maintain the speed rigorously constant for twenty seconds; it is then advisable to use the diapason in the following manner: A small even-surfaced cylinder, coated with candle smoke, is fastened to the axis of the ring; a diapason, vibrating 100 to the second, and bearing a small pen at the end of one of its branches, is then held in the hand. At the precise moment, when the galvanometer indicates the equality of the two electro-motive forces, the pen is applied to the cylinder, and a sinuous line is traced. The application of the pen need be for only a very short time; a half revolution of the ring, indicating some small fraction of a second, being all that is required. Time and space being known, the number of revolutions per second are at once obtained.

The method of opposition theoretically so satisfying is not always easy, and to measure an electro-motive force with any exactness, a thermo-electric pile—neither a convenient nor cheap instrument—should be used. The advantage of Gramme's machine in this instance results from the fact that, unlike ordinary batteries, its electro-motive force may take all possible values from zero. As generally known, it is very difficult to obtain a strictly constant battery current; but exciting Gramme's machine by a regular speed induces a current of absolutely even strength.

APPLICATION TO GALVANO-PLASTIC PURPOSES.

The first machine of this description, made by Mons. Gramme in 1872, has worked ever since to the entire satisfaction of the owners. It has required no repairs; and the only expense of maintenance is that of the oil necessary to lubricate it. These machines were made till the commencement of 1873: and the earlier form weighed 750 kilogrammes, everything included, containing four electro magnet bars, and two coils. The weight of the copper used in their construction was 175 kilogrammes. Their dimensions were 1·30 m. high, and 0·80 m. greatest width. They deposited 600 grammes of silver per hour, requiring for this purpose a force of 75 kilogrammetres (exactly one horse-power).

Since then, calculations and experiments have led to the invention of a new and far superior type, as represented by Fig. 6.

It will be observed that it contains but one ring instead of two, and but two bar magnets instead of four. Particulars are as follows:—

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* *Comptes Rendus de l'Academie des Sciences*, 24th Nov., 1874.

Total weight ..	117·50	kilogrammes.
Weight of copper	47·00	,,
Dimensions:—		
Height ..	0·60	metres.
Width ..	0·55	,,
Deposits	600.	grammes of silver per hour.
Motive force required to work it..	50	kilogrammetres.

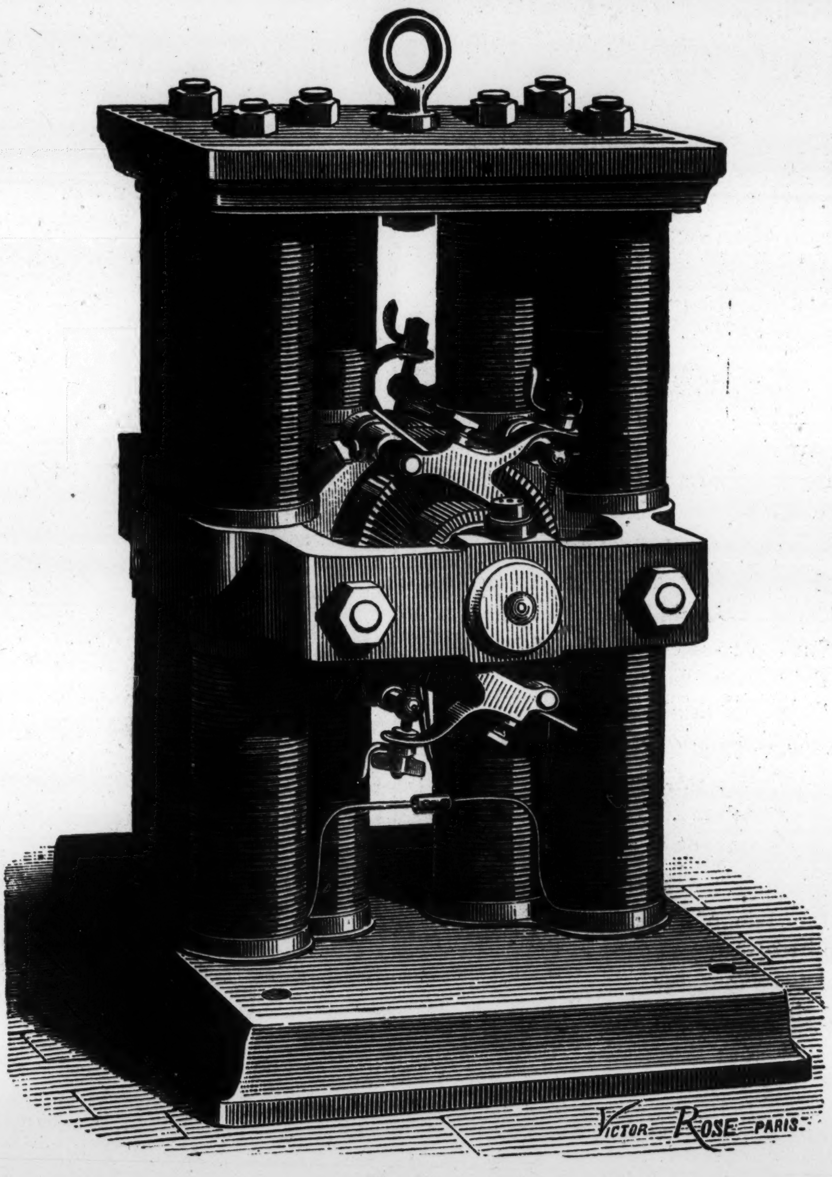

Fig. 6.

This, compared with those previously described, possesses the following advantges:—

1.—Occupies less than half the space.
2.—Total weight reduced by more than three quarters.
3.—Weight of copper reduced by more than three quarters.
4.—30% of motive force economised.

Improvements that are obtained by discarding the exciting coil in placing the electro-magnet in the circuit of the current; and by a better arrangement of the copper fittings. The fittings of the electro-magnets, for instance, were at one time made with round wire, but are now formed of a single band of thin copper, the width of half an electro-magnet bar, so that in reality the two magnets are covered with four bands of copper. The ring or coil is furnished with very thick and flattish wire, offering such sufficient rigidity to sustain the centrifugal force of 500 turns a minute rotary speed. The framework is of great stability, and the minor portions in all respects improved.

The armatures are solidly fixed to the magnets, and embrace almost the entire circumference of the coil.

The arrangement whereby the magnet is placed in the circuit gave rise to an injurious phenomenon of change of pole; for whilst the machines continued in action with circuits closed through metallic baths, the poles remained constant; but, the moment a stoppage took place, a secondary current was immediately set up by the bath, which, traversing the electro-magnet wires gave them a contrary magnetism: hence, on recommencing rotation an *inverse* work was performed. In the case of silver-plating, for example, if a strap fell, was replaced, and work recommenced, the objects in the bath would be un-silvered. To obviate this inconvenience, on the machine slackening the current is cut off automatically. When, after a stoppage, work is to be continued, all that is required is to close the circuit by bringing a small metallic plate (called a "*current-breaker*") into contact with the electro-magnets.

This "*current-breaker*" is a small moveable counterpoise piece that unites the metallic brushes to the electric-magnets. Whilst these latter are magnetised, the current-breaker remains in contact; but, the moment the machine, by slackened speed, reduces the attractive power of the electro-magnet, the counterpoise balances away so as to break connection between the annular coil and the electro-magnets. No secondary current can form, and therefore the poles remain continuously the same.

(To be continued.)

Notes.

MR. F. J. SCUDAMORE, C.B., whose retirement was recently alluded to, has now ceased his duties, and shortly leaves for the East. A handsome testimonial—a purse of 400 guineas—was presented to him by his brother officers. His vacancy as secretary to the Post Office will not be filled up.

Mr. F. E. Baines, well known to all telegraphists, Mr. Scudamore's chief assistant, has been appointed "Surveyor-General for Telegraphs." Mr. C. H. B. Patey succeeds Mr. Baines as principal clerk of the telegraph branch.

The cable between Dartmouth and Guernsey has been repaired, and communication with the Channel Islands is now restored. It was found necessary to use a large amount of entirely new cable.

A new cable is now being manufactured at Silvertown for the Isle of Man, and it is expected communication will be re-opened in the early part of this month. The original cable, which was laid in 1859, was found so deteriorated that a complete renewal was necessary.

The manufacture of the New Zealand cable has been commenced at the works of the Telegraph Construction Company.

The India Rubber, Gutta Percha, and Telegraph Works Company (Limited) have received the following telegram to-day: "Silver, London—Aug. 11. Arica-Iquique section successfully completed. All well.—GRAY, Iquique." This section is about 200 miles long, and the total length of cable laid on the coast of Peru is about 860 miles.

At the meeting to-day of the Mediterranean Extension Telegraph Company (Limited), the report was adopted, and a dividend at the rate of 3 per cent. per annum was declared, as well as the half-yearly dividend on the 8 per cent. preference stock, and £500 was carried to the reserve fund, making it £7,848.

A letter from San Francisco to the *New York Herald* of the 11th inst. says:—"About one year ago a number of leading capitalists of this coast conceived the idea of forming a joint-stock company for the purpose of constructing telegraph lines between this city and New York and all the principal cities throughout the United States and Canada. The project was discussed from time to time, but no direct action was taken until about two months since, when a company was formed and duly incorporated under the laws of the State for the purpose above stated, with a capital stock of 25,000,000 dollars, divided into 25,000 shares. The amount of stock now actually subscribed is 7,500,000 dollars, of which amount 75,000 dollars has been paid up. The principal promoters of this enterprise are A. A. Cohen, C. W. Kellogg, Michael Reese, J. R. Keene. F. D. Atherton, Mr. Sharm, Mr. Burling. These represent an aggregate capital of 25,000,000 dollars to 30,000,000 dollars. They are among the most prominent men on the coast, and noted men of energy and enterprize and business capacity. They propose commencing to build from Ogden East, and will probably buy the right to use existing line to that point. They say they do not intend doing any business until they have completed the line to New York, continuing with Philadelphia, Washington, Boston, and other of the principal cities—in all about 5,000 miles of telegraph lines. They will extend lines throughout the United States and territories and Canada. The estimated length of the company's lines to be completed is 75,000 miles. The work is to be commenced at once. It is the intention of the company to have the line to new York completed and in working order by next spring. They have already made a proposition to parties in New York to open a construction office there for building the line on that side, and also have advertised for proposals to furnish 30,000 poles of the requisite size. There will doubtless be many objections thrown in the way of this enterprise by the company now in operation; but the promoters of the scheme understand that, and are prepared with rates for commercial business as follows:—Ten words from New York to Philadelphia, 10 cents; New York to Chicago, 50 cents. These are special points. The general rates will be as follows:—Within 250 miles, 25 cents; 250 to 500 miles, 50 cents; 500 to 1,000 miles, 75 cents; over 1,000 miles, one dollar. In addition to this the company' by reason of certain arrangements they expect to make, but which they are not prepared to make public, will establish a system of second-class rates at the following tariff:—Within 250 miles, 10 cents; within 500 miles, 15 cents; within 1,000 miles, 40 cents. The principal promoters of the enterprise say they have not started this company for the purpose of interfering with the business of any other line, but as a business speculation, from which they ultimately expect to receive a fair return. They look on it as a business as necessary as cheap postage, and expect, from the great business, they will receive benefit as stockholders as well as business men."

Correspondence.

Edinbro', August 11, 1875.

To the Editor of the TELEGRAPHIC JOURNAL.

Sir,—At page 150 of your journal it is stated that Mr. De Sauty commenced duplex experiments in Gibraltar in March, 1872.

Could you kindly inform me if this should not be 1873? Yours, &c.,

A. EDEN.

NOTE.—Your Correspondent had the misfortune, at the close of 1872, to propose and experiment on the Bridge method of duplexing (in ignorance of Mr. Stearn's prior invention). It would therefore be interesting to know, if even in Gibraltar, it was being tried eight months prior to my own experiments, although the latter were by double currents, and with automatic transmitters at high speeds. A. E.

[It should have been 1873.—ED. *T.J.*]

GATHERINGS FROM THE EDITOR'S NOTE BOOK.

IN one of his dialogues, called "Ion," Plato asserts the power which enabled the poet of that name to win a prize for recitation at a public festival to be "inspiration—a magnetic influence, passing like an electric current from the loadstone of divine essence into the soul of the poet, and from thence into the souls of his hearers." Plato could know nothing of an electric current, but he had the idea of the transmission of an influence from one point to another, which is best translated by that term.

Terquem proposes the following experiments to prove that electric charge remains on the surface of bodies:—He takes a birdcage and suspends it from the prime conductor. He places inside a gold leaf electroscope, pieces of tinsel, feathers, pith balls, —nothing stirs. He suspends inside and out bundles of threads—those inside are unaffected, those outside are affected. Bands of paper outside are excited, ones inside are not affected. He also introduces a bird which is quite indifferent.

Franklin says that electric charge is destroyed—

1st. By gradually sifting fine sand on the electrified body.
2nd. By breathing on it.
3rd. By making a smoke about it from burning wood.
4th. By *candlelight* suddenly—the light of the sun does not dissipate it.
5th. A bright coal and red-hot iron.

Smoke from dry resin dropped on hot iron is attracted by both bodies.

Franklin imagined electricity to be an element of glass—remove electricity and glass would lose its virtues and properties!

The earth and atmosphere play an important part in all electrical phenomena. If air were not an insulator, electric phenomena would be unknown. Its insulating power varies with its hygrometric state.

According to Ferguson—"Green glass, which contains no lead, is better adapted for the construction of electric apparatus than flint glass, and does not attract moisture to the same extent," but Sir W. Thomson says the very reverse.

Loss of charge in air arises from particles of dust floating about and carrying away electricity by convection, but according to Gavarret—"Air, even perfectly dry, carries away from electrified bodies a portion of the charge accumulated upon their surface. The gaseous layers which immediately envelope an electrified body are themselves electrified at their expense by contact. Consequently, they are charged with fluid, they are repelled and yield to new layers, which in their turn borrow from this body a new dose of electricity which they carry away with them. This inevitable and incessant loss produces a progressive diminution of electric charges, the rapidity of which grows from rest with the hygrometric state of the atmosphere." The above explanation is, however, not in accordance with present ideas.

Faraday showed the polarity of electrified materials by a glass trough filled with oil of turpentine, and inserting in it small fragments of *white silk*. When discharges passed the fragments formed a connected chain, which ceased with the discharges. Matteucci used various powders which always formed a linear series.

In a properly constructed electrometer no external influence should exercise any effect upon the moveable conductors. In present instruments the inner surface of glass is liable to become electrified, and does so. Faraday showed that this could be obviated by coating the interior of the glass case with a fine network of tinfoil. A cage of fine wire inside the glass shade will have the same effect. An electrometer is an instrument for measuring, by means of the motions of a moveable conductor, the difference of potentials of two conducting systems insulated from one another.

PNEUMATIC TELEGRAPHS FOR LONG DISTANCES.

Paper read at the meeting of the Society of Civil Engineers of Paris, on the 4th June, 1875.

By M. A. CRESPIN.

(Continued from page 192.)

In examining arrangements of this nature, one is astonished at the small diameter of the tubes generally adopted; thus, in the great English system at St. Martin's-le-grand, the diameter of the tubes is almost exclusively 2¼ inches. Two lines only, the traffic of which is exceptional, and upon which up and down arrangements have been adopted, have been made 3 inches in diameter. The expenditure of air in these tubes is double that in the others, and consequently the English engineers have restricted their use as much as possible.

What is the reason for a size which at first sight appears so small? The answer will be found in examining the conditions under which the line itself is established.

A telegraphic message or a pneumatic letter is always very limited in its size and weight, the amount of matter daily sent through pneumatic tubes by a population of one or two millions of inhabitants is represented by a bulk and weight far from great, and when the comparatively rapid speed with which this matter is passed through the tube is taken into consideration, it is easy to see that it is not at all necessary, in a successful system, for them to be of large dimensions.

Let us make a comparison between the tubes under consideration and other mains or tubes carried underneath the soil in large cities for distributing gas and water, the latter of which, in well supplied towns is furnished to the inhabitants at the rate of about 100 litres per head per day. To afford this, supply mains of about a metre in diameter are employed on the chief routes, and of a smaller diameter on the others; the speed of circulation is at most one metre per second. In the case of the matter conveyed in the pneumatic tubes the amount certainly does not exceed 1 gramme for each inhabitant, or one thousand times less, and the speed in the pneumatic tubes is at least ten times as great; with a section of one millionth, we shall then have made the conditions nearly equal.

If we apply these figures to Paris we find a mean circulation of 10,000 messages per day of 5 grammes each, making a total weight of 50 kilogrammes: these messages distributed into boxes, for passage through the tubes, at the rate of 25 per box, would require 400 boxes or 40 boxes per hour, which could easily be forwarded in four trains despatched at intervals of a quarter of an hour. It is clear that trains might be sent at much more frequent intervals provided, of course, that sufficient power were employed to produce the compressed air and vacuum which would be required.

The tubes employed in Paris have a diameter of 0·065 metres, and would certainly suffice for a traffic of 50,000 messages per day, if the need for for carrying so large a number of messages arose.

In the present state of the question it seems evident that, even taking into account a postal service already well developed, the diameter of a pneumatic tube should never exceed one-tenth of a metre; under these conditions the limit of remunerative cost has been reached, beyond this limit the cost becomes greater than that of a railway. If such a tube is worked by engines of sufficient power, it can transmit as many as 100 boxes per hour, representing nearly 100 kilogrammes weight of messages, which, divided into letters of 20 grammes each, would equal 5,000 of such letters per hour.

It is evident that a traffic of this kind would be far in excess of the amount of work possible at the present time.

We have just seen by what has been previously stated on the subjects of pressure and diameter, that these two elements in the establishment and working of a pneumatic tube, cannot, practically, be extended beyond certain limits; we now proceed to examine the influence of the length itself. We again revert to the fact that all the advantages of a pneumatic telegraph consist in its compensating, by its capacity, for its relative slowness as compared with electricity. It is necessary therefore, if we wish to go far, to go at a high speed; we have just seen within what limits we can avail ourselves of increased pressure and diameter, and the result of our examination is, that a solution of the problem must be sought in some other direction.

The first investigations of the subject date from 1857; they were made by Mr. Latimer Clark, who brought forward the question of the necessity for a mechanical arrangement to allow of the working of lines of comparatively great length. A kind of opening was arranged which was closed by means of special mechanism at the moment a train passed, when the train was being impelled by compressed air, and was opened upon the passage of a train in the opposite direction, drawn inwards by the vacuum.

The advantages of a plan of this kind were indisputable, and we find in the journal *Engineering* of the year 1869 the description of an apparatus proposed by Mr. Sabine, which affords a satisfactory solution of the problem.

Mr. Sabine has taken the case of line similar to one of the principal lines radiating from the Post-office in London, and constituting a line of communication with a point more or less distant by means of trains alternately driven forward by pressure of air, and afterwards drawn back again by a vacuum applied at the end of the tube terminating in the central station.

His arrangement consists of a valve acted upon through a hinged rod by a sort of diaphragm of leather or india-rubber, the latter being influenced through a special tube by the vacuum or pressure at the central station. This diaphragm opens the valve, and when sending by pressure the air, by escaping through the opening, allows the train to traverse the first section as if the line consisted merely of the length between the starting point and the valve. The moment the train passes the opening, it detaches the valve from the rod which connects it with the diaphragm, by the action of a spring; the valve then closes, and the train passes through the second section with the speed proper to a line having the length of the two first sections, and so on.

If the central station draws a train from the extreme end, the apparatus acts in the following manner: by means of the vacuum actuating the diaphragms through the special tube, all the valves are closed, the line can then be exhausted of air in front of the train which, as it passes the valves, acts upon the bolts, and thus disconnects them, so as to allow the air to enter behind the train at the end of each section; the same advantage is thus obtained as when sending by pressure.

The table given below shows the advantage gained by employing this apparatus; a line of ten sections is taken for example.

No. of Section.	Time of transit in each section.		Total time of transit.			Percentage of gain.
			With Valve.	Without Valve.		
1	1		1	1		
2	$\sqrt{2}$	1·41	2·41	$2\sqrt{2}$	2·82	17
3	$\sqrt{3}$	1·73	4·14	$3\sqrt{3}$	5·19	25·4
4	$\sqrt{4}$	2·00	6·14	$4\sqrt{4}$	8·00	30·3
5	$\sqrt{5}$	2·24	8·38	$5\sqrt{5}$	11·20	33·7
6	$\sqrt{6}$	2·45	10·83	$6\sqrt{6}$	14·70	35·7
7	$\sqrt{7}$	2·65	13·48	$7\sqrt{7}$	18·55	37·6
8	$\sqrt{8}$	2·83	16·31	$8\sqrt{8}$	22·64	38·8
9	$\sqrt{9}$	3·00	19·31	$9\sqrt{9}$	27·00	39·8
10	$\sqrt{10}$	3·16	22·47	$10\sqrt{10}$	31·60	40·6

From this table it is seen that the percentage of gain goes on increasing as the line becomes longer; the gain which is 17 per cent. for a line of two sections, with only one apparatus in the middle, increases to 40 per cent. upon a line of ten sections provided with nine of the apparatus distributed throughout its length.

The remedy is, however, far from being a radical one, for, if it allows pneumatic lines to be extended in length, it limits this extension, and the same table which shows the advantage of the apparatus, shows also very clearly the limit of the same extension; for we see that even with the proposed improvements it takes 3·16 times the time to traverse the tenth section that is necessary to pass through the first, and that averaging the gain over the whole length, the mean time occupied is represented by 22·47 instead of 10, which would be the figure were all the sections traversed at the same speed as the first. The mean speed after the tenth section has been passed is less than one half; the time occupied is nearly three times what it ought to be.

The solution of the problem of a line of unlimited length with a constant speed required a more complete apparatus, and it is this apparatus, to which I have given the name of *relay*, that I am about to describe. Its object is to perform in the most complete and exact manner the operations which would be carried out by an attendant who, under conditions about to be described, would have to act in the following manner.

The pneumatic line of extended length has been, as in the case of lines established within the limits of cities, divided into sections of about one thousand metres in length; each of these sections is furnished at its commencement with reservoirs in which is stored up the compressed air, having the pressure and volume necessary for performing the service of the section. The case is exactly the same as that of an intermediate station in a city, provided with means for compressing air; the two lines up and down are arrranged in a straight line, end to end, in such a way that a train received on the up line can pass without impediment into the down line; the attendant, whose presence we assume, would await the arrival by the up line of a train which was being sent to him, allowing the air to escape freely at the end of the section. At the moment when the train passes from the up line into the down line he closes the former behind the train, and opening a cock communicating with his own reservoir of compressed air, by this means drives the train forward along the next section; he keeps the cock open whilst the train is passing to the next station, and closes it when informed of its arrival at the latter point by the attendant there in waiting.

Such are the various operations which must be performed automatically by the relay; the first apparatus used and giving certain results was tried in the month of May, 1873. The trials were made in Paris, upon the direct line from the Central Station to the Bourse; and in London, in the engine-room at Telegraph-street.

At Paris the apparatus was placed under a cast-iron plate, and was connected by special pipes with the reservoirs of compressed air in the station at the Théâtre Français.

This apparatus fulfilled exactly all the operations above described as having to be performed by the attendant supposed to be placed at the intermediate station. The escape of the air took place in front of the relay, where a portion of the tube was perforated on all sides so as to give a passage to the air equal to twice the section of the tube. The closing of the line behind the train, and the opening of communication with the compressed air reservoirs were governed by a kind of trigger, acted upon by the train directly it had passed through the relay. The duration of the blowing was determined by a piston rising in a cylinder through the effect of the internal pressure; the rising of this piston was regulated by the counter-pressure in such a way that the blowing continued somewhat longer than the time necessary. The moment a train arrived at its destination or entered a further section the pressure being destroyed in the line the weight of the regulating piston caused it to fall and remain in position to await the arrival of another train.

The success of this apparatus was complete; it enabled a certain number of trains to be passed to and fro between the Central Station and the Bourse with a saving of more than half the time. The return journey was equally rapid, for the trains were sent by pressure as far as the relay, the escape of air taking place through the perforated part of the tube; the rest of the journey was accomplished by means of vacuum from the Central Station.

The objection made to this apparatus is its delicacy; it contains within it a piece easily broken, this piece is the valve employed to close the line; if a foreign body hinders, even partially, its action the relay becomes nothing but an obstacle preventing, in the most absolute manner, the passage of the trains.

To remedy this objection it became necessary to do away with this valve which, after the description which has been just given, would seem to be the essential feature of the apparatus, since it is that which separates the outlet from the inlet. It could only be removed by suppressing the outlet, and to enable the latter to be dispensed with, the counter-pressure must be taken away.

It is this chain of observation which has guided me to the formation of the plan which I now proceed to set forth, and which completely solves the problem. The line is double acting; by means of special apparatus which are also relays, it is kept constantly exhausted of air, and there is consequently no longer any counter-pressure nor are there any valves in the pressure relays.

By the side of the line, which we may assume to be of unlimited length, are laid two secondary tubes connecting the reservoirs of vacuum and compressed air for the supply of the relays, which are placed in convenient positions along the course of the line. These relays are of two kinds, those destined to exhaust the line of air are placed five kilometres apart where it is intended that trains shall be sent along the line at intervals of a quarter of an hour. The reason for their being placed at this distance apart is, that a rather less space of time is needed for exhausting five kilometres, and there is, therefore, no advantage gained by placing them nearer together. They are of a very simple form, a piston rising in a cylinder carries with it a valve closing the line, and a slide opens the communication with the vacuum reservoirs; the piston is raised in the cylinder on the passage of a train, by the counter-pressure which follows the moving power, it closes the line behind it, and at once starts the exhaustion of the section of line which has just been traversed by the train. The valve of this relay has none of the objections attaching to that of the former relay, seeing that it opens of itself after the exhaustion of the section appertaining to the vacuum relay has been completed, an operation which is generally accomplished in half the time prescribed for the interval between the passage of two trains. Moreover, as these relays are placed every five kilometers, and at least one half of them are in places provided for compressing and exhausting the air, they are under the eyes of the attendants. The pressure relays placed one kilometer apart become simple blowers, opening on the passage of a train, and blowing all the time the train is traversing the section; they merely consist of a piston pushing a counter-weight acting upon a slide, which is the pressure slide, and the regulating piston which stops the admission of air after the blowing has lasted the proper time; the compressed air enters the line by a kind of grating which uncovers openings having twice the sections of the line, and the blowing is governed by the train itself which, acting upon a trigger, lets fall a counter-weight placed upon the piston working the slide. The blowing is instantaneous; it is stopped by the action of the regulating piston which closes the communication leading to the line, and shuts up the compressed air in a small chamber between the point where the communication is thus closed and the slide. The effect of this compressed air at the moment when the pressure is lost in the line, that is to say, at the moment when the train has passed through the section, is to raise the piston acting upon the slide, and to restore everything into position for the arrival of another train. This apparatus, which is the main feature of the new system, is extremely simple, and does not require personal supervision in its working. It is accompanied by a reservoir of compressed air of sufficient capacity for the section.

I need not here discuss in detail the means by which the compressed air and vacuum are to be brought to the reservoirs serving the relays. Any of the methods usually employed for this class of work can be made use of, but the most economical process would, of course, be selected. In a populous country the engine stations might be numerous, and the power employed small. In thinly inhabited countries they might be 20 or 25 kilometres apart, and the power would then have to be greater.

(To be continued.)

The First Idea of the Telegraphic Dial.—In a work written by Father John Laurechon, a Jesuit, printed in 1624, at Pont-à-Eousson, under the title of "Récréation Mathématique composée de plusieurs problèmes plaisants et facétieux," there is to be found a curious passage, well deserving to be quoted:—"It is stated, that by means of a magnet, or any stone of the kind of loadstones, absent persons could communicate with each other; for example, Claudius being in Paris, and John in Rome, if each had a needle rubbed with some stone having the power, as one needle should move in Paris the other could move correspondingly at Rome; Claudius and John could have similar alphabets, and having arranged to communicate at a fixed time every day, when the needle had run three times and a-half round the dial, this would be the signal that Claudius wished to speak to John and to no other. And supposing that Claudius wants to tell John that 'the King is at Paris,' he would move the needle to the letters *t*, *h*, *e*, and so on. The needle of John agreeing with that of Claudius would, of course, move and stop at the same letters, and by such means they could easily understand and correspond with each other. This is a fine invention, but I do not believe there is in the world a loadstone having such a power, and besides it would not be expedient, as then treason would be too frequent and too secret." Father Laurechon used to write under the assumed name of H. Van Etten. Annexed to the passage quoted, there is a diagram of a dial, with the 24 letters, having the needle fixed at the letter A. A similar allusion is to be found in the Dialogues of Galileo.

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To Correspondents.

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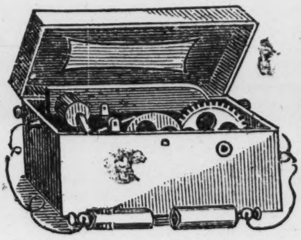

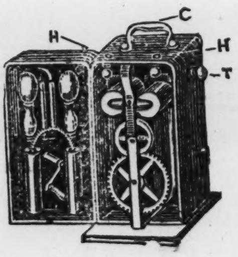

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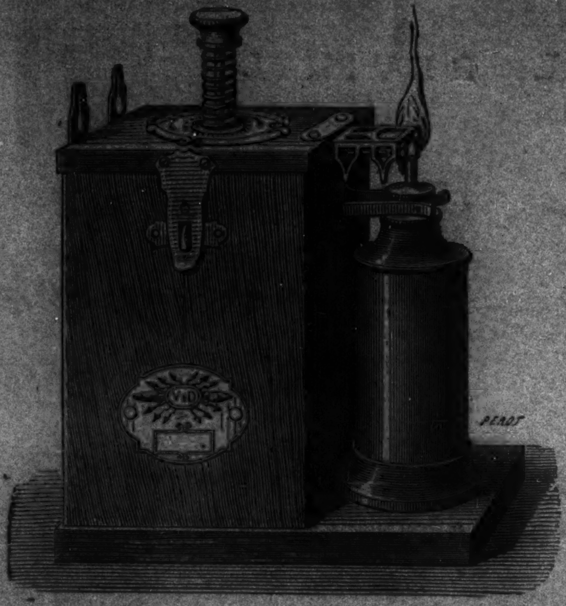

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